

## NEUTRINO and EXTRA WORLD

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The neutrino speed measurement experiments are the continuations of the classic light speed measurement experiments have been done in range of the solar planet system(Ole Roemer-1676), in star system (James Bradely,1728) and, at last, on the Earth( Lois Fizeau, 1849),.... The finite light speed measurement has led to the revolution in the humanity consciousness and eventually led to a new understanding of the visible universe. In 1998-2005, there were a lot of excited discussions at CERN about the possibilities to perform the neutrino experiments to test the superluminal neutrino hypothesis and to find new phenomena beyond the Standard Model[5],[7],[8]. From one hand the idea of such experiments was associated with the hope to understand the role of the  $V - A$ - weak interactions, the quark-lepton family symmetry, the neutrino space-time properties and to observe some indications on a new vacuum structure existence outside of the Weak Scale, *i.e.* in the region  $1/R \sim (0.1 - 20)TeV$ . From another hand the general trends of this idea has been related to the possible existence some extra space-time noncompact dimensions of the universe. In this context it would be first serious encounter with the dual conception between the physical phenomena of microcosmos and of universe. One of the main goals is to find some new space-time peculiarities and structures that might explain the formation of our visible  $D = (3+1)$ -universe with all its space-time and internal symmetries which could be only a part of a vast Universe filled with other kinds of matter. The main difficulties of such experiments related to the possible relativity principle paradoxes have been discussed.

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## 1 Light about Space and Time.

Up to date there are several reasons for considering the possible extension of the observed  $D = (3+1)$ - space-time and its symmetries comprehension. In the first instance a number of fundamental problems in the field of high energy physics encountered in the Standard Model as well as in modern approaches  $D = 10$  superstring theories / D-branes, 11-dimensional M-theory and 12-dimensional F-theory have to be taken into account.

The further great advance in Physics could be related to the progress of a modern mathematics: multidimensional Riemannian geometry, new theories of numbers, algebras and symmetries. Especially, we expect the powerful influence of this progress in the understanding of the basic Standard Model symmetries and beyond, in mysterious neutrino physics and its possible relation to the dark matter and dark energy, in high dimensional Gravity and Cosmology. It could lead to the further development in the understanding of our ambient space-time, the origin of the Poincaré-Lorentz symmetry with the matter-antimatter asymmetry, the geometrical basis of the fundamental physical characteristics:  $EM$ -charge, color, spin, mass.

To date it seems naturally expect that there is necessity to expand our knowledge about new geometrical Riemann and tensor structures in the multi-dimensional spaces to achieve the better understanding of the Standard Model dynamic approaches. These new geometric objects could be associated with some new types of external symmetries (symmetry vacuum), which could allow to create a "reasonable" (renormalized) quantum field theories in multidimensional spaces with  $D > 4$  and to construct the multidimensional generalization of the  $D$ -dimensional pseudo-Lorentz groups, what is an essential feature of the progress in the understanding the principles of the general relativity theory. The differential equations for the propagation of waves in a hypothetical multi-dimensional space-time could have the third- or higher degree with some exotic properties as a result of observing new symmetries.

There have been presented enough experimental arguments that the Special Theory of Relativity is being related to the electromagnetic charged matter what can be applied only in  $D = (3+1)$  Minkowski space-time. The special relativity theory was formulated on the basis of axioms comprise the relativity principle, absolutism and the finite speed of light. Galilean symmetry group has been extended to the group of Lorentz transformations, and Poincaré translation group, and the absolutism of time transformed into absolutism of light. Due to light synchronization in stationary system one can determine time globally. The link time and spatial coordinates between two inertial systems moving relatively to each other at a constant speed is defined by Lorentz transformations. These

transformations can be built on the principle of maximal and constant speed of light and, therefore, locally determine the geometric structure of the electromagnetic vacuum, which is reflected in the fact that these transformations leave the four-dimensional interval  $ds^2 = c^2 dt^2 - dx_1^2 - dx_2^2 - dx_3^2$  invariant. The time geometrization has led to the huge advances in the discovery of amazing phenomena in 4-dimensional space-time. The progress with understanding the light speed axiom was gone in the direct accordance with the progress in the study the Euclidean plane axioms where changing the axiom of parallel lines had led after very long period to the discovery of Lobachevsky spaces and Riemann geometry, and eventually had led to the discovery of the special theory of relativity in Minkowsky  $D = (3 + 1)$ -space-time.

It worth to note that the light speed maximum axiom can be interpreted primarily in close connection with the properties of electro-magnetic vacuum of our visible universe. In Maxwell theory the absolutism of light speed is confirmed by identification the velocity of e.m. waves with the basic fundamental constants characterizing the electromagnetic vacuum structure:

$$c = (\mu_0 \epsilon_0)^{-1/2} \quad (1)$$

The concept of the light speed absolutism in the observable universe was especially emphasized in the analysis of Einstein's fundamental ideas of the special relativity theory. The question of the new forms of the matter existence other than electromagnetic did not arise at those days ! The mysteries neutrino was embedded in physics later.

Attempts of solving the problem of the Standard Model incompleteness were converted into multi-dimensional geometry where there could be a hypothetical sterile Matter (Dark Matter) with his "invisible" radiation in addition to the observed electromagnetic-charged matter and for the description of which there can appear the necessity to generalize some  $D = (3 + 1)$  axioms of the relativity theory. The basic idea of the such new phenomena discovering could be associated with the neutrino (or dark matter) since their unique properties could also spread in the space-time with one or two extra dimensions,  $D = (4 + 1)$  or  $D = (4 + 2)$ , respectively.

To the contrast of the spatial and temporal properties of neutrinos with respect to the similar properties of charged quarks and charged leptons there is a room to consider the observed three neutrino states as a single quantum field in the space of dimension 6, that is, with 2 additional non-compact dimensions, and, in accordance with ternary complexity, one can imagine three implementations of neutrinos as a "particle" - "anti-particle" and "anti-anti-particle" (ternary neutrino model) [7],[8],[9] in analogy with the 4-dimensional Dirac electron-anti-electron(positron) theory[1].

## 2 Electron+positron in $D = (3 + 1)$ dimensions

. Relativistic quantum electrodynamics was formulated on the basis on the internal  $U(1_{EM})$ - and external Lorentz  $SO(3, 1)$ + Poincaré (translation) group symmetries of the gauge boson and fermion fields- photon and electron/positron, respectively. The internal symmetry is related to the local and global conservation of electric charge  $Q_{EM}$ . The external symmetries reflect the fact that our space is isotropic and homogeneous what we observe in the form of the law's conservations of such fundamental parameters as the angular momentum, momentum, energy, mass and life time at rest *etc* in the  $D = (3 + 1)$  universe.

In theory of electron+positron there can be some duality links between the space-time geometrical structure and fundamental properties of the particles [7],[9]. For example, if one knows the fundamental properties of the particles one can get the information such as the ambient space-time dimensions. So, the four-dimensional  $D = (3 + 1)$  space-time with external Lorentz/Poincaré quantum electrodynamics symmetry correctly corresponds to the possible quantum states - electrons+positrons - having the following internal properties: two spin states plus two charge conjugated states, electron/positron.

The finite discrete group symmetries related to the  $C$ -,  $P$ -,  $T$ - transformations make this link more subtle putting it finally to the fundamental theorem of  $CPT$ -invariance [4].

The  $CPT$ -invariance proved in such spaces for local quantum theory gives the very important results such as the equality of the particle and antiparticle masses(and life time):

$$m(\Psi) = m(\bar{\Psi}) \rightarrow \text{binary } CPT - \text{invariance.} \quad (2)$$

Similar to the role of the axiom of constant speed of light in the definition of the global time the conservation laws of these symmetries allow us to determine such fundamental parameters globally in the whole space-time.  $CPT$ -invariance allows to correctly define globally the concept of a particle and its antiparticle in the whole  $D = (3 + 1)$ -space-time.

In this approach the  $CPT$ -invariance and  $Q_{em}$ -conservation law can be the prerogatives for Minkowski  $R^{3,1}$ - space-time where the  $SO(3, 1)$  Lorentz group (Poincaré) symmetry and  $U(1_{em})$  gauge symmetry[5],[7], [8] are valid. So, we want to emphasize that the proposal about the duality between the electric charge conservation and  $CPT$ -invariance can be valid in our Minkowski space  $D = (3 + 1)$  only, but for the hypothetical interactions of the  $Q_{em}$ -charged matter with the new exotic matter, these arguments are not valid anymore.

In this approximation the observation of effects with  $CPT$  invariance violation and/or with  $Q_{em}$  charge non conservation could indicate some new exotic

geometrical vacuum structures at the smaller distances beyond the weak interaction region or/and the existence of some global extra dimensions in universe.

This observation will help us to extend the concepts of particles and antiparticles in the ternary case with 3-neutrino specie, for which a new type of complex conjugation can extend the concept of anti-world to the high-dimensional analogue of  $D = (3 + 1)$ -CPT-theorem [7]. Violation of the conservation laws must be associated with some additional geometry and tensor structures of vacuum and can be linked to the appearance some hypothetical phenomena like new interactions, new particles,... This was vividly illustrated by physics of  $K^0 - \bar{K}^0$ ,  $D^0 - \bar{D}^0$ ,  $B^0 - \bar{B}^0$ ,....mixing (see for example [10]).

The possible Majorano neutrino nature [20] among the all other kinds Standard Model Dirac charged fermions prompts another dynamics of baryo-lepto genesis based on the composite fermion Dirac matter structure created from more simple pra-fermions like Majorano neutrino sterile matter filling the extra dimensional world- Meta-Universe.

The fundamental conception such as idea is related with attempts to figure out a common the  $Q_{em}$  charge Dirac matter creation mechanism with enough reasonable assumption that mechanism is such as must give a duality between the  $Q_{em}$  conservation and  $CPT$  invariance:

$$CPT - invariance \quad \leftrightarrow \quad (Q_{em}) \text{ charge conservation}, \quad (3)$$

*i.e.* the invariance of  $CPT$  in  $D = 4$  space-time means the  $Q_{em}$  charge conservation and vice versa.

Thus, if this kind duality exists, the  $CPT$ -invariance violating processes should accompanied by the electromagnetic charge violation too. May be, it could be one of the reasons why we have not saw some rare decays such as the proton decay. In this case, the idea of grand unification symmetries without the electromagnetic charge origin explanation is not enough to solve the proton stability problem.

Also a similar problem could be related with searches for the rare flavor-changing decay channels such as  $\mu \rightarrow e + \gamma$ ,  $\mu \rightarrow 3e$  etc . First, one must solve the origin of the quark-lepton families problem.

In such approach one can propose a mechanism of the geometrical electromagnetic charge  $Q_{em}$  origin and the Dirac complex matter from more fundamental pra-matter [7]. The Majorano neutrinos with  $m_{Dirac}(D = 3 + 1) = 0$  could be some representatives of a new matter (sterile or dark matter?). The idea can be applied to the further attempts to solve the baryon asymmetry of universe problem linking such question with an origin  $Q_{em}$  charge matter in  $D = (3 + 1)$ -space-time. There is one very remarkable fact

$$|Q_p + Q_e| < 10^{-21} \quad (4)$$

which can indicate the unique origin of the proton(quarks) and electron. It suggests an existence of a hypothetical interaction into high dimensional space connecting the Dirac-charged fermions to the pra-matter. This interaction could be based on a new symmetry beyond Lie groups and can provide the universal electron/proton non-stability mechanism. We add two extra dimensions to illustrate a possible mechanism of this kind interaction with a mass scale near  $M_S \sim 10 - 20 TeV$ - region [7]. Note, that the 3-color "up"- and "down"- quarks states interacting via  $SU(3^C)$ -gauge color bosons at the corresponding distances embedded into  $D = (3 + 1)$ -space-time is connected to the problems of a new quantum charge "color" and fractional magnitudes of electromagnetic charge  $Q = \pm 1/3, \pm 2/3$  origin explanations.

We suppose that these problems could be closely related to a possible extension of the electromagnetic vacuum substructure and its link to the origin of the 3-quark-lepton families.

One could consider some extra compactified dimensions what could change the foam structure of electromagnetic vacuum to find a new quantum number geometrical sense due to its confinement property. Thus, one should to produce the integer values of the charged leptons and the fractional values of quarks by unify way to find electromagnetic charge creation mechanism in universe.

### 3 Neutrinos about the space-time structure of universe.

Exclusive properties of three neutrinos could point out the existence of a new vacuum, with properties different from the properties of the electromagnetic and color vacua. Moreover, it can give some information about the symmetry of this hypothetical vacuum that might be associated with the exceptional properties of the three neutrino states-ternary symmetry [7],[9] in addition to the spin. This new ternary symmetry could shed light on the SM dark symmetry:

$$N(Color) = N(Family) = N(dim.R^3) = 3. \quad (5)$$

So the three types of neutrinos can be described by a single 6-dimensional wave function and it would imply the existence of two additional dimensions. It must be emphasized that the assumed charged matter ternary symmetry must be broken with all the attendant circumstances.

Opposite to the 3-neutrino masses one can see the charged leptons and charged quarks grand mass hierarchies increasing with the number of the families from one to the third:

$$\begin{aligned}
m(e) &\approx 0.5MeV & m(\mu) &\approx 106MeV & m(\tau) &\approx 1.7GeV \\
m(up) &\approx 3.5MeV & m(c) &\approx 1250MeV & m(T) &\approx 175Gev \\
m(down) &\approx 5.5MeV & m(s) &\approx 150MeV & m(B) &\approx 4.5GeV
\end{aligned} \tag{6}$$

Also one can see the reverse hierarchy of life times of the electromagnetic charge particles according to increasing the number of the generations:  $1 \rightarrow 2 \rightarrow 3 \rightarrow \dots$ . There are some peculiarities what could be important for our interpretation of the weak interaction region as a boundary between two vacua: electromagnetic and new hypothetical. The first peculiarity requires to postulate the minimal possible mass in EM-vacuum: electron mass ? Then the "up"- and "down"- quark masses could be expressed through the electron mass and the number of colors :  $1/2(m(up)+m(down)) = N_c^2 m(e)$ . Then the next peculiarity is related to a trend of saturation of the masses with increasing number of the generation.

Under this circumstance it will be important to clarify the following problem: does the fourth generation exist or doesn't? Some superstring models possessing the hypothetical family symmetry expect the fourth quark generation having some exceptional properties[10] In this case one could consider the quaternary extension of ternary hidden symmetry:

$$N(Q-3Color+L-1Color) = N(Fam.-3+Ex.Fam.-1) = N(Dim.R^{3,1}) = 4. \tag{7}$$

The experimental observation of the fourth quark generation could support the idea about real role of weak interactions in the Standard Model and in universe: "screening" at the very small distances beyond the weak interaction region  $r \leq 10^{-17}cm$ . Thus one can suggest that the electromagnetic vacuum could be defined by the light speed and by the minimal Dirac mass magnitudes possible for the stable electromagnetic universe.

One of the our space-time extension possibilities could be due to a new topological cycle  $(\tau, \xi)$  existence and it could be described by independent component such as new time coordinate  $(\tau)$ [5]. In this scenario, the question what is the real time raises again. These ideas implementation should require the construction of the universe new geometric representations and, in particular, to find the Riemann metric tensor and might be another geometrical and tensor structure invariants of extended space-time. In fact, the hypothesis of the second "time coordinate" might be considered as a convenient way to describe the possible extension of the neutrino spread laws different from those projected by special relativity, for example, the light speed maximality principle.

One of the main difficulty of the study the neutrino intrinsic and space-time properties connected with the considerable discrepancy between the huge ex-

perimental data for the processes with neutrinos as products of hadron's decays and very small amount of the processes where the space-time properties of neutrinos clearly manifested . If the analysis of the myriad of the neutrino channel meson decays restore the energy and angular spectrum of the neutrino collapse the further motion evolution of this collapse can contain significant uncertainty ( see for example series of the articles devoted to the study for the formation of neutrino beams [16],[17]). Further only a tiny fraction of neutrinos in these collapses observed in neutrino channels can be identified via the interaction of neutrinos with detector. The ratio of the accelerator produced neutrinos in the collapses to those could be observed in the neutrino detector can be, depending on the experimental conditions, the order of  $\sim 10^{7-10}$ .

This is especially important to review the samples of long base-line neutrino experiments in FNAL NuMi-MINOS [13] and SPS CNGS-LNGS OPERA [18],[14], [19]. The CNGS beam is obtained by accelerating protons to 400 GeV/c and ejecting ones into neutrino channel as two spills, each lasting  $10.5\mu s$  and separated by  $50ms$ . The SPS CNGS cycle is 6 s long. Each spill contains from 2100 bunches with the time substructure  $3 + 2 = 5nsec$  and intensity  $\sim 10^{10} POT$ . The resulting neutrino collapse is formed at the neutrino channel along a distance of  $\sim 1000m$ [18]. The total statistics used for analysis reported in this paper [14] was  $\sim 15000$  events (from  $\sim 60000$  total events) detected in rock and in detector, corresponding to about  $10^{20}$ - protons on target collected during the 2009, 2010, 2011 CNGS runs and the estimation of the total work-time is about  $5 \times 10^7$  sec. So the total number of spills could be about  $< \sim 10^6$  and each spill produces  $< \sim 0.01\nu$ -event in detector or in rock ( the exact numbers one can see in [19]). It gives very complex problem to restore the total information about the all parameters of neutrino collapse spectrum. Naturally the question Whether is there a chance to synchronize neutrino events in such experiments to within less than time of extraction *i.e.*  $\leq 10.5\mu sec$  ? [5]. Sufficiently, Do we know well the spatial and temporal properties of neutrinos to achieve such synchronization accuracy?

This occasion can bring the any kind paradoxes caused by incorrect experimentalist understanding of the space-time behavior dynamics of the neutrino collapses based only on extremely small recorded statistics of the detected neutrino events. The main paradox of such experiments is that the results of long term studies become to be equivalent to the following inference: what had been assumed that it was received. The opportunity of a wrong interpretation of the ambiguous experimental results makes the modern experimental neutrino physics is very complex and raises such experiments at the level of art.

It is well known that neutrino experiments consist of three phases: the neutrino collapse production process, its space-time spread through the matter and



the possible interaction of the collapses with the detector material. The neutrino collapse dynamics moving in space-time is another major challenge because of the proposal that the neutrino is an another kind of matter representative significantly different from the electromagnetic matter. This suggests that neutrinos could spread in accordance with the new vacuum structure kinematics. Despite the existence of three quark-lepton generations the three states forming a single wave field of space-time evolution might be assumed and would be described by the corresponding wave equation. In a ternary model the neutrino wave field could have the own charge - "neutrino light". In this approach the neutrino field could be distributed according to the motion equations different from the equations used in  $D = (3 + 1)$ - geometry defined by the Lorentz group symmetry. It can give some new additional interpretations of the processes related to the well known neutrino oscillations that we plan to publish later.

The possible extra dimensional geometry existence can lead to the circumstance that the neutrino waves could spread by geodesic lines different from the geodesic lines of the electromagnetic charged particles (see for example, [23]). Appears from the above the neutrino flow cannot conserve in the  $D = (3 + 1)$ -space-time. It could be a reason of disappearance of neutrino flows at a distance.

In the article [5] some neutrino experiments were proposed to observe the possible our space-time expansion comprising another cycle characterized by its fundamental speed which could be much faster than electromagnetic light. The last assumption was supported by some arguments to solve the horizon problem in cosmological models [6]. Neutrinos due to their outstanding properties available in both cycles and the electromagnetic light speed maximality principle does not work anymore. In particular, the new multi-dimensional geometrical spaces have the projective symmetries the understanding of them could help us to visualize new universes. Another factor is that the space-time expansion can carry out the introduction of new topological cosmic cycles. It means that these topological cosmic cycles may have own fundamental parameters such as "speed", "mass", "charge",...

Therefore, to check the hypothesis that neutrinos spread different than the light the experiment based on the possibility of measuring the neutrino speed depends on the parameters that might be related to the fundamental another cycle properties has been suggested, and we expected that dependents on such parameter one could get the neutrino speed:  $v_\nu > c_{light}$  ( see the interesting discussions in [22],[24], [25], [26]).

Such experiments could prove the existence the new vacuum and extra dimensions directly but this way involves a very delicate element associated with synchronization "almost invisible" neutrino.

In the classical experiments to measure the new fundamental constant the

validity limits of the special relativity theory need to be understood. For our approach it was necessary to examine on what setting might have changed the neutrino velocity value if it really has a link to the new vacuum. The latter implies that there should be in minds some method of the possible  $D = (3 + 1)$  space-time expansions with the corresponding metric tensor forms for such models. Otherwise such experiments can lead to the logical paradoxes. In fact, such experiments can meet the challenge of measuring the absolute velocity or absolute motion or something else.

#### 4 Compact and non-compact extra dimensions

The main experience we have got from Kaluza-Klein, SS/D- branes,  $D = 11M$ ,  $D = 12F$ - theories and from the study of the Riemann and tensor structures of the high dimensional Cartan symmetric and Berger-nonsymmetric spaces is the compact small and the noncompact large dimensions are closely connected to the origin of internal and external space-time symmetries, respectively, in corresponding theories (see discussion in [9]).

The compact small dimensions are connected with the origin of internal symmetries. The role of the compact Calabi-Yau spaces was perfectly illustrated in the 5-superstring dual theories. Correspondingly, non compact large dimensions are related to the extra space-time symmetries of the our ambient world. For the Standard Model this circumstance could be very important since we suppose that the problem of three neutrino species could be solved by adding the some global noncompact dimensions to our  $D = 3 + 1$  space-time[5],[7]. So the family symmetry appearance can be related to the large noncompact extra dimensions like it was happened with two "families", particle-antiparticle, and was proved by Dirac relativistic equations for the  $D = 3 + 1$ - Minkowski space-time.

In the past a lot of publications has been devoted to the possibility to solve the three family problems through the internal gauge family symmetries introduction. Let note that in superstring approach the  $N = 1$   $SUSY$   $SU(3)_H \times U(1)_H$  gauge family symmetry appears with  $3 + 1$  quark-lepton family [10]. The possible fourth family must have the exceptional properties since this family is singlet under  $SU(3)_H$ -symmetry in this approach. This broken family gauge symmetry could be responsible for the mechanism of  $CP$ -violation in  $K$ -,  $D$ -,  $B$ - meson decays [10]. Thus one can see the common grand problem of the flavor mass hierarchy of quarks and charged leptons, family mixing,  $CP$ -violation that cannot be solved without understanding the role of the  $(V - A)$ -weak interactions.

There is also the very important difference between the three charged quarks/leptons and three neutrino states: Dirac-Majorano space-time nature [1],[2], their masses

and etc. We can expect that for Majorano neutrino species the global family symmetry is exact... To explain the ambient geometry of our world with some extra infinite dimensions one can consider the our visible world (universe) as just a subspace of the universe with the matter having new quantum numbers different from already known in our world.

The visibility of a new world phenomena is determined by the our understanding of the SM structure and its consequences for the Cosmology processes. The Majorano neutrino can travel in this Universe! To make it available we should introduce a new space time-symmetry with the usual D-Lorentz symmetry generalization. In this case the region  $\leq M_S \sim (10 - 20)TeV$  could be considered as a "boundary" of a new world.

So we can start from multi-fermion  $D = 6$  Fermi Lagrangian corresponding to the Fermi constant  $G_{F_S}$  that should have the dimension [7]:

$$G_{F_S} \sim M_S^{-4} \quad (8)$$

In our opinion this coupling constant dimension corresponds to a new interaction that propagator could have a form like  $[P(q, M_S)]$ , where  $P(q)$  could be a polynomial of 4-th degree. Such as propagator form corresponds to a new  $D = 6$ -metric tensor. So, for the tree level calculations of the quark or charged lepton decays into neutral real bulk fermions  $\nu_S$

$$q \mapsto n \nu_S, \quad e^\pm \mapsto n \nu_S \quad (9)$$

can get the following estimation for the partial width

$$\Gamma(e/q \rightarrow n f) \sim O(g_S) \cdot \frac{m_{e/q}^9}{M_S^8}, \quad (10)$$

where  $m_{e/q}$  is the electron mass, and  $M_S$  is a new mass scale related to the hypothetical interaction in extra dimensional world what could be associated to the some new symmetries[27]. What is very interesting that we can construct the universal mechanism of the decays for the all known quarks  $-u, d, s, c, b, t$ - and charged leptons- electron, muon,  $\tau$ lepton- into the  $EM$ -invisible matter. To get the lower boundary for  $M_S$  let's compare the partial width for electron decay with the life time of muon in frame of  $D_4$ -Fermi interactions:

$$\frac{\Gamma(e \rightarrow 3s)}{\Gamma(\mu \rightarrow e \nu \bar{\nu})} = O(g_S/g) \frac{m_e^9}{m_\mu^5} \frac{M_W^4}{M_S^8} \quad (11)$$

From the lower boundary on the electron life time one can get the following upper boundary for  $M_S$ :

$$M_S \geq O(g_S/g) \cdot (10 - 20) \cdot M_W. \quad (12)$$

This boundary has the universal magnitude what one can check from searching the baryon violation processes of neutron

$$N \mapsto 3\nu \quad \text{or} \quad N \mapsto n\nu_S. \quad (13)$$

Apart from charge violation decays we can expect also the the  $CPT$ -invariance violation processes. For example, the  $M_S$  magnitude estimation can be get from the  $K^0$ - $\bar{K}^0$ - mass difference:

$$\delta_m = |m - \bar{m}| \sim \frac{m^5}{M_S^4} < 10^{-15} GeV. \quad (14)$$

This estimation show that the  $M_S$  can be also in  $1 - 10TeV$  region.

## 5 The paradoxes of special theory of relativity in neutrino experiments.

The measurements of neutrino speed on the accelerator experiments can be associated with Fizeau experiment to measure the speed of Light. Opposite to Fizeau ideology in the neutrino projects [5] there must be studied three main discrepancies what are related to the some experimental and theoretical ambiguities. In contrast to the Fizeau experiment to measure the speed of neutrinos was a very daunting task to identify and synchronize the departure of neutrinos or neutrino wave collapse formed during the release of the accelerator proton bunch on the target. The second discrepancy was related to the understanding the structure of neutrino collapse formed in the neutrino channel and getting all its parameters. The third important discrepancy was linked to the driving dynamics of neutrino fronts propagating over long distances, *i.e.* to represent its evolution during the flight from accelerator till detector . To solve the third problem one should have the information about possible some new spatial - temporal properties of neutrinos, *i.e.* that is to construct or have some sorts of models explaining the physical reasons why the neutrinos properties could be beyond some principles of special theory of relativity, in particularly to overcome the speed of light. If you do not accept this ideology the experiments of measurements the neutrino velocity will involve with attempts to measure the "absolute motion" ( Aristotle, Galilei). The main conclusion from this discussion is how to measure correctly speed of the objects with the properties completely different from the electromagnetic media (new time structure, synchronization). To make such experiments one can coincide themselves to the paradoxes of measurement the absolute movement. In electromagnetic media- universe and vacuum- only light can have the property of absolutism,  $c$  is invariant fundamental constant .

Between energy and wave length there exists the quantum link:  $E_\gamma \cdot \lambda_\gamma = c \cdot h$ , where  $h$  is Plank constant. If neutrino is not related to the supersymmetry [21] or some unknown yet now phenomena in the frames of the special theory of relativity there appear the ambiguous situation. Absolutism of neutrinos? In special theory we know how to synchronize the events in electromagnetic media. Now there can appear grand question how to synchronize the events in a new vacuum media. In this regard, in our projects, [5] we were looking for those neutrino observable parameters that could link the neutrino with a new vacuum in which the laws of the  $D = (3 + 1)$ - electromagnetic universe could not be valid any more. Other vacuums different than electromagnetic can have new fundamental properties what we suggested to check in the experiments related to the measurements the propagator properties of neutrino like its velocity. The extra dimensional (non trivial) generalization of the Lorentz group could imply the existence of another boost and possible extensions the concept of the time, even its structure, what we understood from theory of relativity? To find the confirmation of existing of exotic vacuum structure beyond the electromagnetic one should look for the experimental measuring parameters of neutrinos what could connected to the other hypothetical world. Or we can meet to the Aristotle - Galilei absolute movement problem. We know enough well the ways to synchronize electromagnetic events on the long distances using the light. But the many neutrino phenomena we don't know yet well to be sure that we can synchronize correctly the neutrino events. In neutrino experiments made during some last years there was realized only the first part of the projects [5] what was based on conclusions of the the first measurement the neutrino velocity in 1977 FNAL[11] and in 1987  $24+5(=11\text{KII}+8\text{IMB}+5\text{B})+(5\text{MB})$ -neutrino events getting from SN87A and detected in KAMIOKANDAIL, IMB, BAXAN, Mont-Blanc [12]. From that observations there has been done the main conclusion that the magnitude of the speed of neutrino should be very closed to the corresponding magnitude of the light speed. This circumstance Since neutrino could link both worlds for neutrino the principle of absolutism of light is not valid more and we can take the energy as possible such parameter. The other possible parameter could be related to the sources of neutrinos since it gives the information about the region of neutrino production on the smaller and smaller distances. In this choice it will be important to study the possible spatial and temporal structures of neutrino fluxes having the wide energy spectrum, producing from certain sources and moving on the different distances. We can compare the ideology of neutrino experiments [11], [12],[13],[14], [15] to the our conceptions [5]. As examples we can consider the productions of neutrino fluxes in SPS CERN from regular extractions of proton bunches in which the energy of proton beams equal to  $E_p = 400\text{GeV}$  with regular extractions

during  $3nsec$  with separation  $500nsec$  and intensity about and  $10^{11}POT$ . For each extraction one can estimate the corresponding neutrino energy spectrum of  $10^{8,9}$  neutrinos with the primary period about  $3nsec$ . For us it will be important to make the analysis of time and spatial expanding of this bunch on some different distances:  $83km, 366km, 732km, 1464km$ . In line with the hypothesis about the existence of  $(1 + 1)$ - extra dimensions we suggested that the expanding of neutrino fluxes depends on some parameters,  $\{t, L, E_\nu, k_i(r), c_i(y)\}$ , where  $t, L, E_\nu$  are ordinary parameters what we can measure in the experiments, parameters  $k_i$  are related to the type of sources of neutrino (muon,  $\pi$ - and  $K$ - mesons, *charm, beauty, -quarks, ...,* parameters  $c_i$  should be directly linked to the fundamental characteristics of a new vacuum, depending on the type of a new hypothetical metric tensor. As a result of this approach the spread of the neutrino collapses will be completely different from the flow of electromagnetically charged particles, i.e. the expansions of neutrinos must be beyond the laws determined by standard Lorentz  $D = (3 + 1)$ -metrics[5]. As we approached the speed of the neutrino is not absolute characteristic for the electro-magnetic vacuum there was made the assumption that the neutrino energy could one of the parameters binding our vacuum with a new vacuum. We proposed that the speed of neutrino could depend on the energy what we were searching through ternary or quaternary extensions of  $D = (3 + 1)$ -metrics ( $ds^2 = f_1(y_a)ds_{3,1}^2 + f_2(x_\mu)ds_y^2$ ).

As a possible variant, one can consider that the speed of neutrino is the product of electromagnetic charged particles could have some deviations from the speed of light:  $(v_\nu/c - 1)_i \approx k_i \cdot (E_{nu}/M_S)^2$ , where constant  $k_i$  is determining by the region on neutrino production, for example, in our examples we consider two cases, neutrino from  $\pi$  - and  $K$ -meson decay for which  $r \sim 1/m_\pi$  and  $r \sim 1/m_K$ , correspondingly. In our scenario, the behavior of the neutrino velocity at superhigh energies could be in accordance with the formula  $v_\nu \sim c_2 E^2 / (E^2 + M_S^2)$ . The proposed dependence of neutrino speed from the energy leads to the substantial change of the spatial and temporal picture of the neutrino collapses. Thus according to articles [5] we consider two variants of taking parameters what could help to observe the effects of existing a new space-time vacuum structure: 1. *energy of neutrinos*, or 2. *distance on what neutrino was "born"*. For illustrations in the first case we consider the neutrinos formed only from  $\pi$ -meson decays in CNGS neutrino channel formed as a result of the discharge of protons on target with the energy of  $400 GeV$  in certain time intervals(see fig(1) and fig(2). For this case the coefficients  $k_\pi$  is related to the magnitude of the wave function distribution of *up*- and *down*- quarks inside the  $\pi$ -meson structure region. For the second case we considered the possible parents of neutrino- kaons(see fig(3). In this case we take into account both

variants-energy and origin of production . The distribution of the neutrino energy formed from leptonic and semi-leptonic decays K-meson decays for which we take the following coefficients for  $k_K \sim (m_K/m_\pi)^2$  . According to [5] the neutrino velocity effect should more significant for neutrinos produced from the heavy quark decays. This one can see also on the figures fig(3) where the temporal spread of the  $\nu_K$ - neutrino collapses can be much more than it was in  $\nu_\pi$ -cases. For illustration we can give the distributions of  $\nu$ -fluxes from *SN87A* at  $M_S = 0.1-0.2-0.5-1TeV$ (see fig(4)). This cosmic experiment may be the first time gives us a hint about what the neutrinos cross the huge spatial and time intervals according to other laws. To draw concrete conclusions from this experiment is difficult to do. Any predictions depend on the theory of stellar evolution, and the structure of the tremendous medium through which the neutrino waves swept generated in the depths of supernova [12]. At the end we would like to illustrate (see fig(5)) that there could be a dual link between the changing the geometrical structure of the  $D = (3 + 1)$ - vacuum on very small distances and possible new phenomena of our Universe observed on the very big distances, for example, the acceleration of Universe expansion.

## 6 Conclusions

Conclusions from the data obtained in experiments [13], [14], [15] require a thorough rethinking. In such experiments the main accent has been done on the solving of the problem synchronization of two "neutrino" events: production and detection. To solve this problem it was assumed that the spatial-temporal behavior of neutrinos is determined by the laws of the Lorentz group symmetry and the special theory of relativity  $\psi_\nu \sim (\exp ik \cdot x)$ . Not taken into account that neutrinos can have extraordinary spatial and temporal properties different from the charged matter ( for example, in ternary or in quaternary description one can take the following generalization of the plane waves:  $\psi_\nu \sim \exp i(k \cdot x) + j(p \cdot y)$  ). Therefore, the conclusions of the neutrino velocity measurement cannot unambiguously interpreted and that was illustrated in the previous section. One can count that these experiments collide to the paradoxes of absolute movement. In such experiments their results correspond to common proposal that the neutrino collapses propagate through the space similar to the light fluxes.

To measure the speed of neutrinos in these experiments it was achieved good time resolution but for the proposed ideas for solving the synchronization problem the energy resolution was not sufficiently precise. The energy can be measured with poor accuracy at least 20 percent. This is due to several reasons:

- 1.Bad identification of the charged and neutral currents. In the neutral current neutrino takes a lot of energy

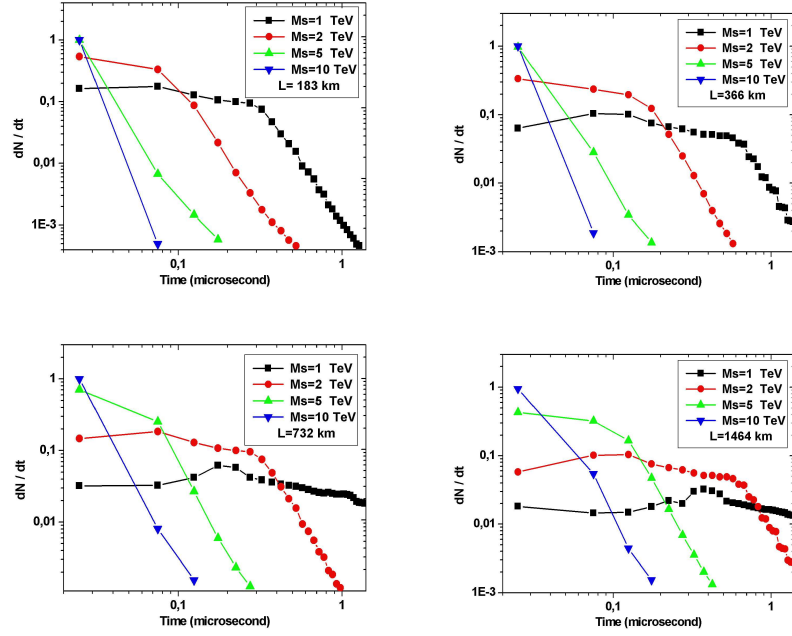


Figure 1: The temporal distributions of the intensity of the neutrino fluxes for the only one bunch of the output proton beam at energies  $E = 400 GeV$  [18]. The duration of one bunch is equal to 3 nanoseconds, the gap between the neighboring bunches equals 500 nanoseconds. Consider the case of formation of the neutrino fluxes from  $\pi$ -meson decays. Four figures of distributions  $\nu_\pi$ - fluxes at the different scales:  $M_S = 2-, 5-, 10-, 20 - TeV$  on the distance  $183 km, 366 km, 732 km, 1464 km$ .



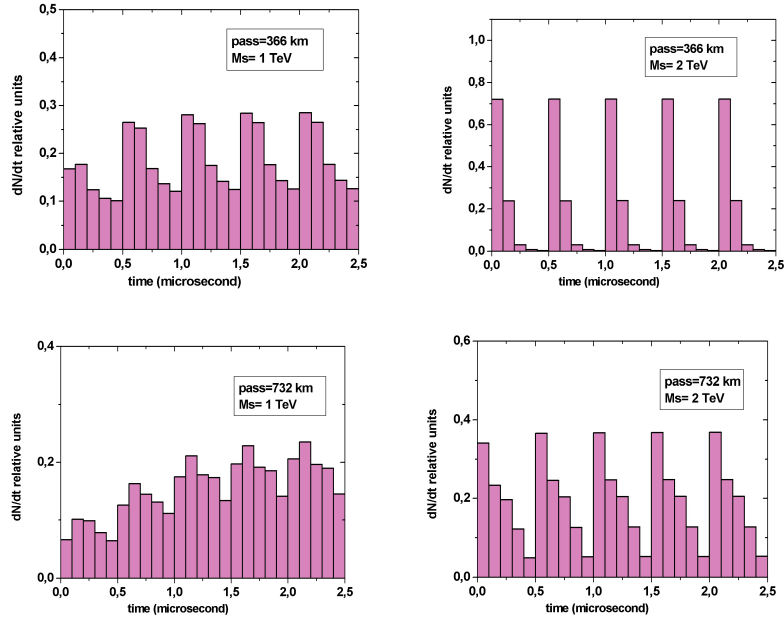


Figure 2: The temporal distributions of the intensity of the neutrino fluxes for 5-bunches from the output proton beam with energy  $E = 400\text{GeV}$  at a distances of 366km and 732 km.  $M_s = 1\text{ TeV}$  to  $2\text{ TeV}$ . The duration of one bunch is equal to 3 nanoseconds, the gap between the neighboring bunches equals 500 nanoseconds. Consider the case of formation neutrino fluxes from  $\pi$ -meson decays.

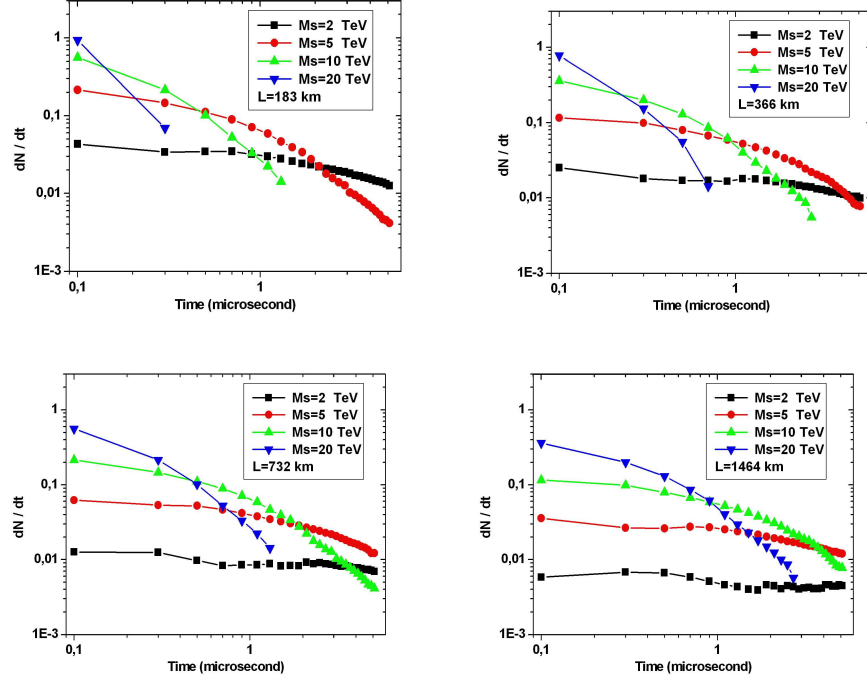


Figure 3: The temporal distributions of the intensity of the neutrino fluxes for one bunch produced by the proton beam with energy  $E = 400\text{GeV}$ [18]. The duration of one bunch is equal to 3 nanoseconds, the gap between the neighboring bunches equals 500 nanoseconds. Consider the case of formation of neutrino fluxes from  $K$ -meson decays. Four figures of distributions of  $\nu_K$ - fluxes at the different scales:  $M_S = 2-, 5-, 10-, 20 - \text{TeV}$  and on the distances  $183\text{km}$ ,  $366\text{km}$ ,  $732\text{km}$ ,  $1464\text{km}$ .

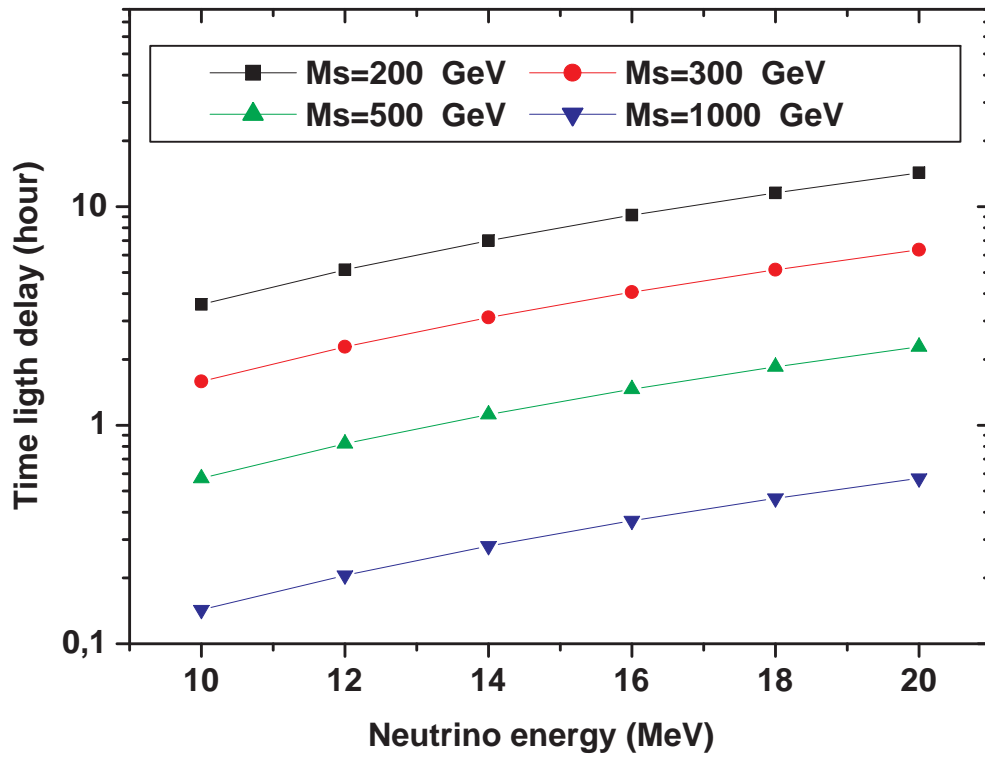


Figure 4: Distributions of  $\nu$ -fluxes from  $SN87A$  at  $M_S = 0.1-0.2-0.5-1 TeV$

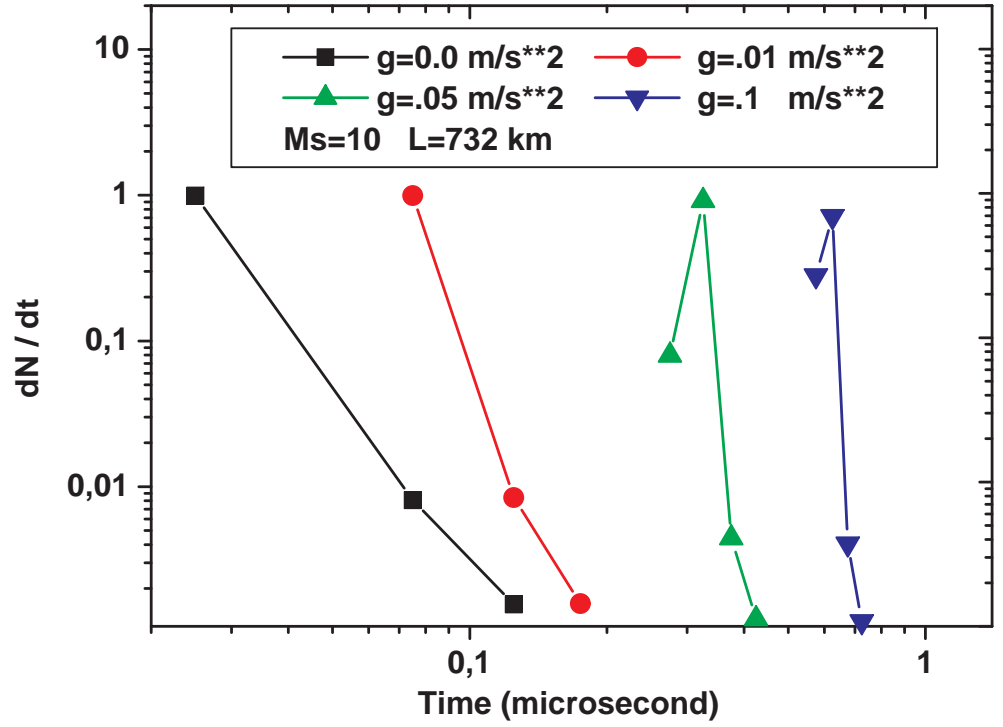


Figure 5: Figure shows how will the neutrino ahead of an electromagnetic wave, if we assume that the neutrino is moving with acceleration. Set value of the acceleration are shown in the figure. In the calculations assumed that the acceleration is the same for the entire spectrum of neutrinos. Estimates are only for neutrinos formed from  $\pi$ -meson decays.

- 2. Energy carried away by neutrons poorly defined.
- 3.  $\pi$ -meson is often indistinguishable from the proton.
- 4. The observation of several events, secondary events are mixed up.

The number of problems with the definition of the neutrino energy can increase the detector containing passive elements. Also there is the problem of resolution of the rock neutrino events. For the normalization of neutrino spectra would be important to study the dependence of registered neutrino fluxes on the energy and distance. In fact, the experimental limits on the speed of neutrinos obtained in these experiments can not be proven as maintain synchronization depends on the specific assumptions. In our opinion, the problem that was posed in the works [5] requires a whole series of serious studies under different conditions: wide diapason of the proton energy extractions till some TeV, short and long distances, different time of proton extraction, different neutrino specie, etc. There might be very important the questions connected to the decrease of the flux intensity dependent on the distance what can be occur due existence of extra dimensions and which naturally expected in the ternary model neutrino. So evolution of neutrino flux with distance and energy can also test the hypothesis of non-compact extra dimensions.

Our examples showed that the new ideology about role of  $(V - A)$ -weak interactions and  $Q - L$ -family symmetry and neutrino mysteries phenomena still needs to make new more detail experiments. Opposite, the experiments will come to the paradoxes like what now we have got good chance to observe and to study in the last attempts of the measurements the speed of neutrino [13], [14], [15]. Neutrino still conserve its mysteries. Also one can see from our examples that it is better to make the measurements on neutrino velocity with high neutrino energy. From proton/electron stability we took the upper bound for  $M_S \sim 20TeV$  [7]. Since there can be presented other models this class of neutrino experiments needs to continue the investigations. From our figures one can see how to make the analysis of such experiments in future to check the models what could be confirmed or excluded.

In our projects [5], there have been done suggestions to measure the global characteristics of neutrino flux motion in spatial-temporal picture. But we knew that in the case of neutrinos the successful implementation of these projects is determined by the our knowledge of the actual properties of the neutrino as a

particle and a wave. This is very difficult problem, we tried to address as part of a complete picture of the modern standard model and the role of its neutrino. In addition to simply observe the effect was very important to understand the possible dynamics of it, depending on the parameters ( energy, distance,etc) which we offered. We have seen that achieving very high accuracy timing lights are not enough to properly interpret the experimental results. Ultimately, our goal was not a measurement of the speed of light with neutrinos, just vice-versa. Otherwise, we will come to paradoxes, confusing interpretation of the results.

If we have chosen as a parameter the energy of neutrino or the depth of its generation was important to experiment with the original beams of protons in the energy range of completely different. Since it was suggested that the effect of advancing the speed depends on the neutrino energy is natural to take the neutrino program high or extremely high energies, which may already could been done in the nearest future on the accelerator modern complexes FNAL and CERN. One can say that such experiments are linked to the another class of neutrino experiments with high energies opposite to the ideology of the experiments what are going to measure the neutrino oscillations. We should note that this class of super-high energy neutrino experiments with different bases including very long distances can be very important for the future of the SM-physics and beyond. For example, on such experiments it might be done the experiments of measurement the total cross section of neutrino interactions with its dependence on the distance between the source of neutrino beams and detectors. The neutrino experiments with high or super-high energies will be able to significantly expand the possibilities of progress in discovering the secrets of neutrinos if you do not play a decisive role. In our opinion, the two programs, low-energy neutrino physics associated with the study of the oscillations, and the physics of ultra-high energies will only complement each other....

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